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UTILITY  
PATENT APPLICATION  
TRANSMITTAL

Attorney Docket No. 4800-090

First Inventor

Dyakonov et al.

Title

A SMOKING ARTICLE INCLUDING A SELECTIVE CARBON  
MONOXIDE PUMP

(Only for new nonprovisional applications under 37 CFR § 1.53(b))

Express Mail Label No.

EL681324306US

## APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

## ADDRESS TO:

Assistant Commissioner for Patents  
Box Patent Application  
Washington, DC 20231

1. ☒ Fee Transmittal Form (e.g., PTO/SB/17)  
(Submit an original and a duplicate for fee processing)
2. ☐ Applicant claims small entity status.  
See 37 CFR 1.27.
3. ☒ Specification [Total Pages 13]  
(preferred arrangement set forth below)  
— Descriptive title of the Invention  
— Cross Reference to Related Applications  
— Statement Regarding Fed sponsored R & D  
— Reference to sequence listing, a table,  
or a computer program listing appendix  
— Background of the Invention  
— Brief Summary of the Invention  
— Brief Description of the Drawings (if filed)  
— Detailed Description  
— Claim(s)  
— Abstract of the Disclosure
4. ☒ Drawing(s) (35 U.S.C. 113) [Total Sheets 3]
5. ☐ Oath or Declaration [Total Pages 1]  
a. ☐ Newly executed (original or copy)  
b. ☐ Copy from a prior application (37 C.F.R. 1.63(d))  
(for continuation/divisional with Box 18 completed)  
i. ☐ DELETION OF INVENTOR(S)  
Signed statement attached deleting  
inventor(s) named in the prior application,  
see 37 CFR 1.63(d)(2) and 1.33(b).
6. ☐ Application Data Sheet. See 37 CFR 1.76

7. ☐ CD-ROM or CD-R in duplicate, large table or  
Computer Program (Appendix)
8. Nucleotide and/or Amino Acid Sequence Submission  
(if applicable, all necessary)  
a. ☐ Computer Readable Form (CFR)  
b. Specification Sequence Listing on:  
i. ☐ CD-ROM or CD-R (2 copies); or  
ii. ☐ paper  
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## ACCOMPANYING APPLICATION PARTS

9. ☐ Assignment Papers (cover sheet & document(s))
10. ☐ 37 CFR 3.73(b) Statement ☐ Power of Attorney  
(when there is an assignee)
11. ☐ English Translation Document (if applicable)
12. ☐ Information Disclosure Statement (IDS)/PTO-1449 ☐ Copies of IDS  
Citations
13. ☐ Preliminary Amendment
14. ☒ Return Receipt Postcard (MPEP 503)  
(Should be specifically itemized)
15. ☐ Certified Copy of Priority Document(s)  
(if foreign priority is claimed)
16. ☐ Request and Certification under 35 U.S.C. 122(b)(2)(B)(i).  
Applicant must attach form PTO/SB/35 or its equivalent.
17. ☐ Other: \_\_\_\_\_

18. If a CONTINUING APPLICATION, check appropriate box, and supply the requisite information below and in a preliminary amendment, or in an Application Data Sheet under 37 CFR 1.76:

☐ Continuation ☐ Divisional ☐ Continuation-in-part (CIP)  
Prior application information: Examiner:of prior application No: \_\_\_\_\_ / \_\_\_\_\_  
Group/Art Unit:

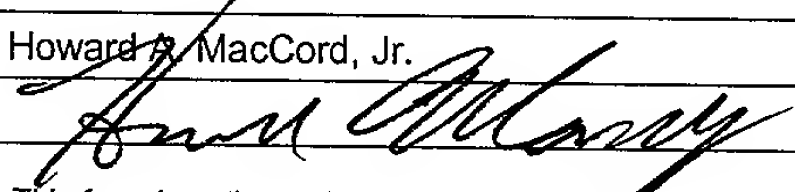
For CONTINUATION OR DIVISIONAL APPS only: The entire disclosure of the prior application, from which an oath or declaration is hereby incorporated by reference. The incorporation can only be relied upon when a portion has been inadvertently omitted from the submitted application parts.

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**FEE TRANSMITTAL  
for FY 2001***Patent fees are subject to annual revision.**Complete if Known***TOTAL AMOUNT OF PAYMENT** (\$1,756.00)

Application Number

Filing Date

First Named Inventor

Dyakonov et al.

Examiner Name

Group Art Unit

Attorney Docket No.

4800-090

**METHOD OF PAYMENT**

- 1.
- ☒
- The Commissioner is hereby authorized to charge indicated fees and credit any over payments to:

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Deposit  
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Rhodes &amp; Mason, P L L C

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- Charge Any Additional Fee Required
- 
- Under 37 CFR 1.16 and 1.17

☐ Applicant claims small entity status. See 37 CFR 1.27

- 2.
- ☒
- Payment Enclosed.

☒ Check ☐ Credit card ☐ Money Order ☐ Other**FEE CALCULATION****1. BASIC FILING FEE**

Large Fee Code	Entity Fee (\$)	Small Fee Code	Entity Fee (\$)	Fee Description	Fee Paid
101	710	201	355	Utility filing fee	710.00
106	320	206	160	Design filing fee	
107	490	207	245	Plant filing fee	
108	710	208	355	Reissue filing fee	
114	150	214	75	Provisional filing fee	
<b>SUBTOTAL (1)</b>					(\$)710.00

**2. EXTRA CLAIM FEES**

	Extra Claims	Fee from below	Fee Paid
Total Claims	47	-20** = 27	X 18 = 486 00
Independent Claims	10	-3** = 7	X 80 = 560 00
Multiple Dependent			

Large Fee Code	Entity Fee (\$)	Small Fee Code	Entity Fee (\$)	Fee Description
103	18	203	9	Claims in excess of 20
102	80	202	40	Independent claims in excess of 3
104	270	204	135	Multiple dependent claim, if not paid
109	80	209	40	**Reissue independent claims over original patent
110	18	210	9	**Reissue claims in excess of 20 and over original patent
<b>SUBTOTAL (2)</b>				

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**FEE CALCULATION (continued)****3. ADDITIONAL FEES**

Fee Code	Large Entity Fee (\$)	Fee Code	Small Entity Fee (\$)	Fee Description	Fee Paid
105	130	205	65	Surcharge - late filing fee or oath	
127	50	227	25	Surcharge - late provisional filing fee or cover sheet	
139	130	139	130	Non-English specification	
147	2,520	147	2,520	For filing a request for <i>ex parte</i> reexamination	
112	920*	112	920*	Requesting publication of SIR prior to Examiner action	
113	1,840*	113	1,840*	Requesting publication of SIR after Examination action	
115	110	215	55	Extension for reply within first month	
116	390	216	195	Extension for reply within second month	
117	890	217	445	Extension for reply within third month	
118	1,390	218	695	Extension for reply within fourth month	
128	1,890	228	945	Extension for reply within fifth month	
119	310	219	155	Notice of Appeal	
120	310	220	155	Filing a brief in support of an appeal	
121	270	221	135	Request for oral hearing	
138	1,510	138	1,510	Petition to institute a public use proceeding	
140	110	240	55	Petition to revive - unavoidable	
141	1,240	241	620	Petition to revive - unintentional	
142	1,240	242	620	Utility issue fee (or reissue)	
143	440	243	220	Design issue fee	
144	600	244	300	Plant issue fee	
122	130	122	130	Petitions to the Commissioner	
123	50	123	50	Processing fee under 37 CFR 1.17(q)	
126	180	126	180	Submission of Information Disclosure Stmt	
581	40	581	40	Recording each patent assignment per property (times number of properties)	
146	710	246	355	Filing a submission after final rejection (37 CFR §1.129(a))	
149	710	249	355	For each additional invention to be examined (37 CFR §1.129(b))	
179	710	279	355	Request for Continued Examination (RCE)	
169	900	169	900	Request for expedited examination of a design application	

Other fee (specify)

\*Reduced by Basic Filing Fee Paid

**SUBTOTAL (3)** (\$0)**SUBMITTED BY**

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28,639

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Signature

Date

11/28/00

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I hereby certify that this paper, which is a Utility Patent Application entitled A  
**SMOKING ARTICLE INCLUDING A SELECTIVE CARBON MONOXIDE PUMP**  
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Mailed By:

  
Tammy Shearer

# **A SMOKING ARTICLE INCLUDING A SELECTIVE CARBON MONOXIDE PUMP**

## **Background of the Invention**

5           The present invention relates generally to smoking article and, more particularly, to a carbon monoxide pump for removing carbon monoxide from main stream smoke during the combustion of a smoking article.

Investigators have been trying now for about twenty years to find ways to lower the amount of carbon monoxide experienced by smokers when main stream  
10 smoke is inhaled. One of the issues with respect to carbon monoxide is the amount of carbon monoxide actually contained or produced by a smoking article. For example, an average amount of carbon monoxide produced by a smoking cigarette is as high as about 10-15 milligrams (mg). To adsorb this amount of carbon monoxide would require a very large amount of adsorbent for carbon monoxide if it was all intended to  
15 be trapped by such an adsorbent. This is impractical and cost prohibited.

An alternative approach to adsorbing carbon monoxide is to oxidize it, for example, by the catalytic oxidation to carbon dioxide. A difficulty with this approach is that the temperature of the main stream smoke is substantially that of the environment. These low temperatures make it difficult to oxidize carbon monoxide to  
20 carbon dioxide even when using a catalyst.

Thus, there remains a need for a method and apparatus for carbon monoxide reduction in cigarette smoke.

## **Summary of the Invention**

25           The present invention fulfills this need by providing a smoking article including a tobacco column; a wrapper surrounding the tobacco column; and a carbon monoxide pump. The pump includes an adsorbent for adsorbing carbon monoxide and may include a catalyst for oxidizing carbon monoxide to carbon dioxide. In use, the carbon monoxide pump selectively diverts carbon monoxide from main stream  
30 combustion products, the catalyst at least partially oxidizes the carbon monoxide to carbon dioxide and the venting holes provide an alternative path for the diverted carbon monoxide and the oxidized carbon monoxide to reduce inhalation by a

smoker. In a preferred embodiment, venting holes adjacent to the adsorbent facilitate the further diversion of carbon monoxide from main stream smoke

A preferred catalyst is a transition metal including rare earth metals and a platinum group metal. Preferred transition metals include at least one of copper, cobalt, iron, silver, nickel, their alloys, their mixtures and combinations thereof, with silver being the most preferred. The transition metal may be elemental, an oxide, or combinations thereof.

In an embodiment, the CO pump includes at least one additional filter element, preferably cellulose acetate. A catalyst may be distributed through the at least one additional filter element

In the vicinity of the adsorbent, the concentration of carbon monoxide is increased, thereby increasing the flux of carbon monoxide from the adsorbent. The adsorbing is momentary, preferably for between about 0.1 and about 10 seconds.

In a preferred embodiment, the adsorbent is a zeolite such as an oxide, more preferably, at least one of silicon, aluminum, magnesium, their mixtures and their compounds. A dehydrated oxide, particularly of aluminum has been found to be effective. An amorphous oxide may also work. In a preferred embodiment, the adsorbent is a support for the catalyst.

Accordingly, one aspect of the present invention is to provide a smoking article including a tobacco column; a wrapper surrounding the tobacco column; and a carbon monoxide pump including an adsorbent for adsorbing carbon monoxide, wherein the carbon monoxide pump is aligned with the tobacco column so as to selectively divert carbon monoxide from main stream combustion products prior to inhaling by a smoker.

Another aspect of the present invention is to provide a carbon monoxide pump for use in a smoking article including a tobacco column and a wrapper surrounding the tobacco column. The carbon monoxide pump includes an adsorbent for adsorbing carbon monoxide, and a catalyst. When placed adjacent to the tobacco column, the carbon monoxide pump selectively diverts carbon monoxide from main stream combustion products by adsorbing carbon monoxide, and the catalyst at least partially oxidizes the diverted carbon monoxide to carbon dioxide prior to being inhaled by a smoker.

Still another aspect of the present invention is to provide a smoking article including a tobacco column; a wrapper surrounding the tobacco column; and a carbon monoxide pump. The pump includes an adsorbent for adsorbing carbon monoxide; a catalyst for oxidizing carbon monoxide to carbon dioxide, and venting holes adjacent to the adsorbent. In use, the carbon monoxide pump selectively diverts carbon monoxide from main stream combustion products, the catalyst at least partially oxidizes the carbon monoxide to carbon dioxide, and the venting holes provide an alternative path for the diverted carbon monoxide and the oxidized carbon monoxide to reduce inhalation by a smoker.

The invention also provides a mouthpiece for a smoking article including a fitting to receive a smoking article, and a carbon monoxide pump including an adsorbent for adsorbing carbon monoxide, wherein the carbon monoxide pump is positioned with respect to the smoking article so as to selectively divert carbon monoxide from main stream combustion products prior to inhaling by a smoker.

These and other aspects of the present invention will become apparent to those skilled in the art after a reading of the following description of the preferred embodiment when considered with the drawings.

#### **Brief Description of the Drawings**

FIGURE 1A is a smoking article according to the present invention;  
FIGURE 1B is an exploded view of the smoking article of Figure 1A;  
FIGURE 2 is a schematic of a tobacco column adjacent to a selective carbon monoxide pump according to the present invention;  
FIGURE 3 is a block flow diagram for a carbon monoxide pump according to the present invention; and  
FIGURE 4 is a partial perspective view of a mouthpiece according to the invention.

#### **Description of the Preferred Embodiments**

Referring now to the drawings in general and Figure 1 in particular, it will be understood that the illustrations are for the purpose of describing a preferred embodiment of the invention and are not intended to limit the invention thereto. As





expressed from smoking article. In embodiments having no venting holes 18, inherent pores within the paper provide a path for the expression of oxidized carbon monoxide. Carbon dioxide, generated from carbon monoxide, may also remain in the main stream smoke, providing no harm to the smoker.

5 In an alternative embodiment, having no catalyst, the carbon monoxide pump 16 includes an adsorbent material. In this embodiment, as the main stream smoke passes over the adsorbent material, carbon monoxide is adsorbed from the main stream smoke onto the adsorbent material. During the delay between the current puff and the successive puff, which may be called an inter-puff period, the concentration  
10 of carbon monoxide increases in gas phase within the adsorbent material due to its desorption. The higher concentration of the carbon monoxide in the vicinity of the adsorbent material creates a driving force that increases the flux of carbon monoxide from the adsorbent material so that it exits holes 18 proximate to the carbon monoxide pump 16.

15 As best seen in Figure 3, the drawing, diversion and expression cycles continue during the consumption of the smoking article and in this manner, the amount of carbon monoxide inhaled by the smoker is substantially reduced.

The following examples provided to give a better understanding of the invention and its operation through a discussion of the synthesis, testing and  
20 characterization. The examples are in no way meant to limit the scope of the claimed invention.

Example 1. Gas chromatographic analysis using a Model No. 6890, manufactured by Hewlett Packard, and an infrared CO sensor, manufactured by Filtrona, Inc., were used to determine the gas phase content of cigarette smoke under  
25 standard smoking conditions using a filling machine, manufactured by Filamatic, Inc., reconstructed to a smoking machine. As part of this analysis, the removal of CO from the gas was studied using an artificial mixture comprising helium with about 2% carbon monoxide by volume. About 1% by volume nitrogen was added to this mixture as an internal standard. Catalytic oxidation of CO was also studied using a  
30 mixture of helium, about 2% CO by volume, and about 13% oxygen. The above concentrations were prepared to simulate the average characteristics of tobacco smoke.



During analysis, the gas mixture was passed through the an about 2 milliliter (ml) GC gas loop, manufactured by Hewlett Packard, at about atmospheric pressure. The adsorbent to be studied was loaded into a stainless steel tube reactor. Adsorption was then studied by injecting the content of the gas loop into a pure helium flow of about 200 ml/min rate; the CO mixture with the carrier gas was then passed through the adsorbent in the reactor. The resultant gas was then passed to the GC for analysis. The reactor was maintained at about room temperature during these experiments. The reactor was also used to pre-treat solid adsorbent samples at elevated temperatures.

Aluminum oxide was tested for CO adsorption application because of its Lewis acidity; this property is known to promote CO chemisorption. The experimental results showed that fresh alumina is inactive in adsorption of CO at about room temperature. It is believed that the equilibration of the ambient atmosphere with the alumina surface blocks any CO active adsorption sites. For example, water molecules from the ambient atmosphere may occupy the CO active adsorption sites.

Heating of alumina ( $\text{Al}_2\text{O}_3$ ) to about 300-350°C in air provided an improvement in CO. If water molecules occupy the CO active adsorption sites, a dehydration (e.g., desorption of water molecules) of the CO adsorption sites may explain the increased activity after heat treating. Applicants believe that the CO adsorption property of alumina may be enhanced by altering the surface structure of alumina by for example making it more irregular, as for example, in zeolites.

Example 2. Zeolites ranging in aperture size from about 3 to about 9 angstroms ( $\text{\AA}$ ) were applied in a study of CO adsorption from a pulsed gas. A fixed bed reactor, filled with zeolite, produced delays in the CO pulse; these delays resulted from a relatively weak adsorption. Size-selective dry molecular sieves created larger delay times when a 5 $\text{\AA}$  aperture size approximately matched the diameter of CO molecule.

It was determined that the high affinity of zeolites for water reduces the CO trapping activity of about 5 $\text{\AA}$  zeolite. An effective decrease in the zeolite pore sizes caused by the adsorption of water molecules appears to initiate this reduction. Experiments supported this idea, showing that a hydrated about 9 $\text{\AA}$

zeolite possessed substantially the same CO adsorption activity as that of an about 5Å dehydrated sample. Results also suggest that zeolites with a pore size of about 5Å or greater may be used as a starting material to develop a carbon monoxide pump that diverts CO from main stream smoke.

5            Example 3. An Ag<sub>2</sub>O/ about 5Å zeolite and an Ag<sub>2</sub>O/about 9Å 13X zeolite catalyst/adsorbents were prepared. About 5 grams (g) of silver nitrate were dissolved in about 15 ml of an about 10M NH<sub>4</sub>OH solution that was then combined with water for dilution to about 50 ml. About 20g of about 0.4 to about 0.8 millimeter (mm) beads of a zeolite were added and allowed to remain  
10 overnight for a silver exchange. Each zeolite mixture was shaken frequently for about the first hour to remove evolved air. The catalyst was thoroughly washed with about 2L of water, dried for about 2 hours in air at about 60°C and overnight at about 150°C to decompose [Ag(NH<sub>3</sub>)<sub>2</sub>]NO<sub>3</sub>. After this treatment the resulting light-yellow catalyst was stored in a jar.

15            The removal of CO from a gas was studied using freshly prepared samples in the reactor and the gas mixtures described in Example 1. About 300 milligrams (mg) of each CO pump material were loaded in a filter. Experimental results showed reductions of CO in main stream smoke as high as about 50-60% by volume.

20            Example 4. Catalyst/adsorbent samples comprising Ag<sub>2</sub>O-on-about 13X zeolite (about 9Å) from Lancaster, and CP861E (about 7Å) and CBV5524G (about 5Å) from Zeolyst International were prepared substantially as described in Example 3. Atomic absorption analyses using a Spectr AA-100, manufactured by Varian, provided the concentrations of silver in the samples. These  
25 concentrations are summarized in Table 1 and the corresponding CO removal activities are summarized in Table 2.

Table 1: Concentration of Silver in Zeolite-Supported Catalysts/Adsorbents from AA Analysis Data.		
Sample	Support	% silver
1	13X zeolite (Lancaster)	8.5
2	CBV5524G (NN 2..4 are from Zeolyst)	4.0
3	CP861E (exchanged/milled/sieved)	10.0
4	CP861E (milled/sieved/exchanged)	7.8

Also, zeolites containing silver showed high activity in the catalytic oxidation of CO at higher temperatures. A study of the kinetics of oxidation of CO on silver oxide and a partially reduced silver catalyst revealed that silver catalysts reduced at about 110-150°C were more active in oxidation of CO, and may provide about 70% removal of CO from main stream smoke. However, applicants believe that an excessively active catalyst may provide poor CO removal because of its irreversible deactivation by of other combustion products (see for example sample 2 in Table 2 having a small zeolite pore size).

Table 2: CO Removal from Main stream Smoke by Modified Cigarette Filters, Containing Ag/zeolite CBV5524G (about 5Å)		
Sample	Filter and Cigarette	% CO removed
1	Ag <sub>2</sub> O/Z in vented filter	about 60
2	#1, reduced CO at about 120°C	about 0
3	Ag <sub>2</sub> O/Z in non-vented filter	about 22
4	Ag <sub>2</sub> O/Z in tobacco	about 37

Note: Sample 4 contained approximately the same amount of Ag/zeolite adsorbent, but distributed in the tobacco.

The results summarized in Table 3 indicate that a similar treatment of Ag/zeolite at about 120°C in a reducing gas containing CO may led to an increase in CO removal from about 50 to about 71%, when zeolite as large as about 9Å was used. Even after about 3 hours in humid room air, CO removal activity was not decrease and was measured as at about 81%. These results were confirmed when zeolite CP861E with an aperture size of about 7Å was used.

Corresponding data are summarized in Table 5.

As indicated by the results summarized in Table 3, a higher reduction temperature of about 150°C does not further improve the performance of a catalyst compared to the sample, heat-treated at 120°C. These results imply that a partial reduction of silver in a Ag/zeolite adsorbent/catalyst may be a useful treatment, positively affecting the CO removal effectiveness. CO removal conditions however, must be carefully predetermined and controlled to avoid an over-reduction of silver.

As the results summarized in Table 2 shows, an about 5Å zeolite, used in a non-vented cigarette, provides a lower degree of CO removal of about 22%.

Also, the results indicate that the performance of this CO pump material may be slightly improved when Ag/zeolite material is mixed with tobacco rather than placed in a filter. Applicants believe this occurs since CO concentrated on an adsorbent during a puff is diffused out of the cigarette between puffs. Diffusion of CO through the porous cigarette paper in the case of an adsorbent mixed into the tobacco may be faster than that through a filter paper of a vented CO pump.

The results summarized in Table 6 indicate that venting holes in the CO pump, as well as a thinner paper, facilitate the removal of CO from main stream smoke (e.g., an about 7Å zeolite, modified with silver, was used in a vented and a non-vented CO pump). The effectiveness of CO removal was found to be about 73% and about 27% respectively.

The results of Table 3 show that an Ag/zeolite 13X-based materials did not completely lose its activity after about one cigarette smoked. These materials retained enough activity to provide about 30% CO removal from a second cigarette. This may allow less material in a CO pump.

Table 3. CO Removal from Main stream Smoke by Modified Vented Cigarette Filters Containing Ag/zeolite 13X (about 9Å).		
Sample	Filter	%CO removed
5	Ag <sub>2</sub> O/Z	about 50
6	#5, reduced CO at 120°C	about 71
7	#6 oxidized 3 hrs in air at room T	about 81
8	2 <sup>nd</sup> run of #7 with a new tobacco rod	about 32
9	#5, reduced CO at 150°C	about 55
10	2 <sup>nd</sup> run of #9 with a new tobacco rod	about 30

Table 4. CO Removal from Main stream Smoke by Modified Vented Cigarette Filters Containing (Ag+Pd)/zeolite 13X.		
Sample	Filter	%CO removed
11	(Ag <sub>2</sub> O+Pd)/Z	about 50
12	#11, reduced CO at 120°C	about 75

Table 5. CO Removal from Main stream Smoke by Modified Vented Cigarette Filters Containing Ag/zeolite CP861E (about 7Å).		
Sample	Filter	%CO removed
13	Ag <sub>2</sub> O/Z	about 42
14	#13, reduced CO at 120°C	about 56
15	#14, oxidized 5 hrs in air at room T	about 37

Note: Zeolite was modified, milled and sieved to about 40-60 mesh.

Table 6. CO Removal from Main stream Smoke by Modified Cigarette Filters Containing Ag/zeolite CP861.		
Sample	Filter and Cigarette	%CO removed
16	Ag <sub>2</sub> O/Z in vented filter	about 73
17	#16, kept in cigarette for 2 hrs	about 48
18	#16, kept in cigarette for 1 day	about 45
19	#16, kept in cigarette for 2 days	about 26
20	#16, kept in cigarette for 3 days	about 22
21	#16, kept in cigarette for 10 days	about 50
22	Ag <sub>2</sub> O/Z in non-vented filter	about 27
23	#22, kept in cigarette for 0.5 hr	about 9

Note: Zeolite was milled, sieved 40-60 mesh and modified with Ag compound.

- 5 A feature of adsorbent preparation appears evident from data summarized in Tables 5 and 6. Sample 13 in Table 5 was prepared beginning with a silver water phase exchange procedure done to whole zeolite grains of about 2x6 mm size. After silver deposition the adsorbent was milled, sieved and packed in a filter. The effectiveness of this filter was about 42%; this effectiveness varied
- 10 slightly from both an about 120°C reduction material and a long-term storage material.

- Sample 16 in Table 6, was made starting with a milled and sieved CP861 zeolite. Removal of CO by this material exceeded about 70%; its activity remained significant, although reduced, even after about 10 days at about room
- 15 temperature in a vented CO pump. This result suggests that it may be preferred to a shape and sieve a zeolite prior to silver incorporation.

Example 5. Nickel oxide particles, modified with the rare-earth element dysprosium, were embedded into large-pore molecular sieves. These materials readily adsorb substantially all of the GC-detected, gas-phase organic molecules

except light hydrocarbons. The filtering properties of the adsorbent appeared to be similar to that of activated carbon. The Ni/Dy/zeolite system also demonstrated significant carbon monoxide adsorption activity.

About 10g of nickel acetate  $\text{Ni}(\text{CH}_3\text{HOO})_2 \cdot 4\text{H}_2\text{O}$ , from the Fisher Company, dissolved in 100 ml water, were mixed with about 30g zeolite CBV300-X16 from the Zeolist International Company. The zeolites were used as about 1x4 mm extruded granules. The mixture was retained at about room temperature for about 5 days to facilitate nickel ion exchange. The solution was then decanted and the zeolites were thoroughly washed with cold water.

About 3g of dysprosium chloride  $\text{DyCl}_3$  (grade REO), from Strem Chemicals, were dissolved in about 50 ml water and mixed with the solid material. The mixture was retained at about room temperature for about 5 additional days to exchange  $\text{Dy}^{3+}$  ions into the matrix. The solution was decanted. The solid material was washed with plenty of water, dried at about 50°C for about 2 days and annealed at about 350°C for about 2 days in air. The catalyst was stored in air as about 1x4 mm granules. Before conducting experiments, the sample was milled and about 40-60 mesh size particles were sieved off to be used in a CO pump.

About 500 mg of the catalyst were packed adjacent to tobacco in non-vented and vented research cigarettes. About 70% CO removal from main stream smoke was obtained in both cases. Also, GC analysis of the filtered tobacco smoke showed about 90% removal of acetaldehyde, acrolein and other functional derivatives, as well as unsaturated hydrocarbons. The adsorbent behaved essentially like an activated carbon with respect to these compounds (e.g., low selectivity).

Example 6. Zeolite samples impregnated with copper and palladium ions were similarly prepared using their corresponding chlorides. Palladium salt was dissolved in aqueous HCl so that the  $\text{H}_2\text{PdCl}_4$  complex was used in place of the ammoniacal complex.

Copper- and palladium-containing zeolite of about 5Å showed minor CO activity at about room temperature. Applicants believe that the high temperature activity and sensitivity to poisons (both known characteristics of copper and



palladium compounds) explain the results.

Example 7. Three samples were formed by distributing hydrochloric acid-doped polyaniline in both about 3Å and about 9Å zeolite samples, and on the surface of a cellulose/acetyl cellulosic cigarette filter. About 5g of the  
5 corresponding zeolite or the cellulose acetate filters, taken from research cigarettes, were placed in about 300 ml solution of 5g aniline in an about 1M aqueous HCl. This suspension was mixed for about 20 hrs at about room temperature for aniline adsorption on carbon. The resulting solids were filtered and washed with about 500 ml water and about 100 ml of an about 1M HCl  
10 solution. The supported aniline was suspended in about 300 ml of an about 1M HCl solution that was then cooled on ice.

About 11g of ammonium persulfate (about 98% pure) were dissolved in about 200 ml of an about 1M HCl solution. The solution was cooled on ice and slowly added to the suspension, while maintaining the temperature below about  
15 10°C under a vigorous magnetic stirring. The temperature was allowed to self-equilibrate to about room temperature in about 2 hrs and stirring was continued for about another 20 hrs.

The resulting solids were filtered and washed with about 1L water on a filter and suspended in about 300 ml of an about 1M NH<sub>4</sub>OH solution under  
20 mixing for about another 20 hrs. The supported polymers were washed with about 1L of water on a filter. The solid materials were suspended in about 300 ml of an about 1M HCl solution under mixing for about another 20 hrs. The final products, the HCl-doped supported polymers, were thoroughly washed in about 2L of water, filtered, dried in air at about room temperature for about 24 hrs and  
25 stored.

Polyaniline embedded into about 3Å and about 9Å zeolite matrices showed very low CO adsorption activity. However, the same polymer supported on a cellulose/cellulose acetate cigarette filter adsorbed CO from the first cigarette puff. The following puffs remained unchanged because of the low  
30 adsorptive, irreversible capacity of polyaniline.

The invention can also be carried out by providing a mouthpiece for a smoking article (such as a cigarette or cigar) to which the smoking article is attached



We Claim:

1. A smoking article including  
a tobacco column;  
a wrapper surrounding the tobacco column; and  
5 a carbon monoxide pump including an adsorbent for adsorbing carbon monoxide, wherein the carbon monoxide pump is positioned with respect to the tobacco column so as to selectively divert carbon monoxide from main stream combustion products prior to inhaling by a smoker.
- 10 2. The smoking article according to Claim 1, further including venting holes adjacent to the carbon monoxide pump.
3. The smoking article according to Claim 2, wherein the venting holes facilitate the further diversion of carbon monoxide from main stream smoke.
- 15 4. A carbon monoxide pump for use in a smoking article including a tobacco column and a wrapper surrounding the tobacco column, the carbon monoxide pump including:  
an adsorbent for adsorbing carbon monoxide; and  
20 a catalyst,  
wherein when place adjacent to the tobacco column, the carbon monoxide pump selectively diverts carbon monoxide from main stream combustion products prior by adsorbing carbon monoxide and the catalyst at least partially oxidizes the diverted carbon monoxide to carbon dioxide prior  
25 to being inhaled by a smoker.
5. The carbon monoxide pump according to Claim 4, wherein the catalyst is at least one of a transition metal, an oxide of a transition metal, and a transition metal and an oxide of a transition metal.
- 30 6. The carbon monoxide pump according to Claim 5, wherein the transition metal is a rare earth metal.

7. The carbon monoxide pump according to Claim 5, wherein the transition metal is a platinum group metal.

8. The carbon monoxide pump according to Claim 5, wherein the transition metal is at least one of copper, cobalt, iron, silver, nickel, their alloys, their mixtures and combinations thereof.

9. The carbon monoxide pump according to Claim 4, further including at least one additional filter element.

10. The carbon monoxide pump according to Claim 9, wherein the additional filter element is cellulose acetate.

11. The carbon monoxide pump according to Claim 9, wherein at least a portion of the catalyst is distributed through the additional filter element.

12. The carbon monoxide pump according to Claim 4, wherein in the vicinity of the adsorbent the concentration of carbon monoxide is increased thereby increasing the flux of carbon monoxide from the adsorbent.

13. The carbon monoxide pump according to Claim 4, wherein the adsorbing is momentary.

14. The carbon monoxide pump according to Claim 13, wherein the adsorbing is between about 0.1 and about 10 seconds.

15. The carbon monoxide pump according to Claim 4, wherein the adsorbent is a zeolite.

16. The carbon monoxide pump according to Claim 4, wherein the adsorbent is an oxide.

17. The carbon monoxide pump according to Claim 16, wherein the oxide is an oxide of at least one of silicone, aluminum, magnesium, there mixtures and there compounds.

5 18. The carbon monoxide pump according to Claim 17, wherein the oxide is a dehydrated oxide.

19. The carbon monoxide pump according to Claim 18, wherein the dehydrated oxide is an oxide of aluminum.

10

20. The carbon monoxide pump according to Claim 16, wherein the oxide is amorphous.

21. The carbon monoxide pump according to Claim 12, wherein the  
15 adsorbent is a support for the catalyst.

22. A smoking article including:  
a tobacco column;  
a wrapper surrounding the tobacco column; and  
20 a carbon monoxide pump including:  
an adsorbent for adsorbing carbon monoxide;  
a catalyst for oxidizing carbon monoxide to carbon dioxide, and  
venting holes adjacent to the adsorbent,  
wherein the carbon monoxide pump selectively diverts carbon  
25 monoxide from main stream combustion products, the catalyst at least  
partially oxidizes the carbon monoxide to carbon dioxide and the venting  
holes provide an alternative path for the diverted carbon monoxide and the  
oxidized carbon monoxide to check inhalation by a smoker.

30 23. The smoking article according to Claim 21, wherein the venting holes facilitate the further diversion of carbon monoxide from main stream smoke.

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24. The smoking article according to Claim 21, wherein the catalyst is at least one of a transition metal, an oxide of a transition metal, and a transition metal and an oxide of a transition metal.

5 25. The smoking article according to Claim 24, wherein the transition metal is a rare earth metal.

26. The smoking article according to Claim 24, wherein the transition metal is a platinum group metal.

10

27. The smoking article according to Claim 24, wherein the transition metal is at least one of copper, cobalt, iron, silver, nickel, their alloys, their mixtures and combinations thereof.

15 28. The smoking article according to Claim 21, further including at least one additional filter element.

29. The smoking article according to Claim 28, wherein the additional filter element is cellulose acetate.

20

30. The smoking article according to Claim 28, wherein at least a portion of the catalyst is distributed through the additional filter element.

25 31. The smoking article according to Claim 21, wherein in the vicinity of the adsorbent the concentration of carbon monoxide is increased thereby increasing the flux of carbon monoxide from the adsorbent.

32. The smoking article according to Claim 21, wherein the adsorbing is momentary.

30

33. The smoking article according to Claim 32, wherein the adsorbing is between about 0.1 and about 10 seconds.



34. The smoking article according to Claim 21, wherein the adsorbent is a zeolite.

35. The smoking article according to Claim 21, wherein the adsorbent is an oxide.

36. The smoking article according to Claim 35, wherein the oxide is an oxide of at least one of silicon, aluminum, magnesium, there mixtures and there compounds.

37. The smoking article according to Claim 36, wherein the oxide is a dehydrated oxide.

38. The smoking article according to Claim 37, wherein the dehydrated oxide is an oxide of aluminum.

39. The smoking article according to Claim 35, wherein the oxide is amorphous.

40. The smoking article according to Claim 31, wherein the adsorbent is a support for the catalyst.

41. A method for pumping carbon monoxide from the main stream smoke of a smoking article including a tobacco column a wrapper surrounding the tobacco column, said method comprising:

positioning a carbon monoxide pump including an adsorbent for adsorbing carbon monoxide, with respect to the tobacco column so as to selectively divert carbon monoxide from main stream combustion products prior to inhaling by a smoker.

42. A method for pumping carbon monoxide from the main stream smoke of a smoking article including a tobacco column a wrapper surrounding the tobacco column, said method comprising the steps of:

providing a carbon monoxide pump including:

5

an adsorbent for adsorbing carbon monoxide; and  
a catalyst,

10

wherein when place adjacent to the tobacco column, the carbon monoxide pump selectively diverts carbon monoxide from main stream combustion products prior by adsorbing carbon monoxide and the catalyst at least partially oxidizes the diverted carbon monoxide to carbon dioxide prior to being inhaled by a smoker.

43. A method for pumping carbon monoxide from the main stream smoke of a smoking article including a tobacco column a wrapper surrounding the tobacco column, said method comprising the steps of:

15

providing a carbon monoxide pump including:

an adsorbent for adsorbing carbon monoxide;  
a catalyst for oxidizing carbon monoxide to carbon dioxide, and  
venting holes adjacent to the adsorbent,

20

wherein the carbon monoxide pump selectively diverts carbon monoxide from main stream combustion products, the catalyst at least partially oxidizes the carbon monoxide to carbon dioxide and the venting holes provide an alternative path for the diverted carbon monoxide and the oxidized carbon monoxide to check inhalation by a smoker.

25

44. A method for reducing carbon monoxide in main stream smoke of a smoking article that has a tobacco column comprising:

30

positioning a carbon monoxide pump in the path of the main stream smoke;  
combusting the tobacco in the tobacco column;  
drawing smoke from the combusting tobacco past the carbon monoxide pump;

adsorbing carbon monoxide from the main stream smoke onto an adsorbent;

catalytically oxidizing carbon monoxide to carbon dioxide at the adsorbent; and

5                   expressing carbon dioxide through venting holes adjacent to the adsorbent.

45.     A method for reducing carbon monoxide in main stream smoke of a smoking article that has a tobacco column comprising:

10                   positioning a carbon monoxide pump in the path of the main stream smoke;

                  combusting the tobacco in the tobacco column;

                  drawing smoke from the combusting tobacco past the carbon monoxide pump;

15                   adsorbing carbon monoxide from the main stream smoke onto an adsorbent;

                  releasing the carbon monoxide from the adsorbent and expressing carbon monoxide through venting holes adjacent to the adsorbent.

20     46.     A mouthpiece for a smoking article comprising:

                  a fitting to receive a smoking article, and

                  a carbon monoxide pump including an adsorbent for adsorbing carbon monoxide, wherein the carbon monoxide pump is positioned with respect to the smoking article so as to selectively divert carbon monoxide from main  
25                   stream combustion products prior to inhaling by a smoker.

47. A mouthpiece for a smoking article comprising:

a fitting to receive a smoking article, and

a carbon monoxide pump including:

5

an adsorbent for adsorbing carbon monoxide;

a catalyst for oxidizing carbon monoxide to carbon dioxide, and

venting holes adjacent to the adsorbent,

10

wherein the carbon monoxide pump selectively diverts carbon monoxide from main stream combustion products, the catalyst at least partially oxidizes the carbon monoxide to carbon dioxide and the venting holes provide an alternative path for the diverted carbon monoxide and the oxidized carbon monoxide to check inhalation by a smoker.

15

### **Abstract of the Disclosure**

A smoking article includes a tobacco column, a wrapper and a carbon  
monoxide pump. The pump includes an adsorbent for adsorbing carbon monoxide  
5 and may include a catalyst for oxidizing carbon monoxide to carbon dioxide and  
venting holes adjacent to the adsorbent. The carbon monoxide pump selectively  
diverts carbon monoxide from main stream combustion products, the catalyst at least  
partially oxidizes the carbon monoxide to carbon dioxide and the venting holes  
provide an alternative path for the diverted carbon monoxide and the oxidized carbon  
10 monoxide to check or reduce carbon monoxide inhalation by a smoker.

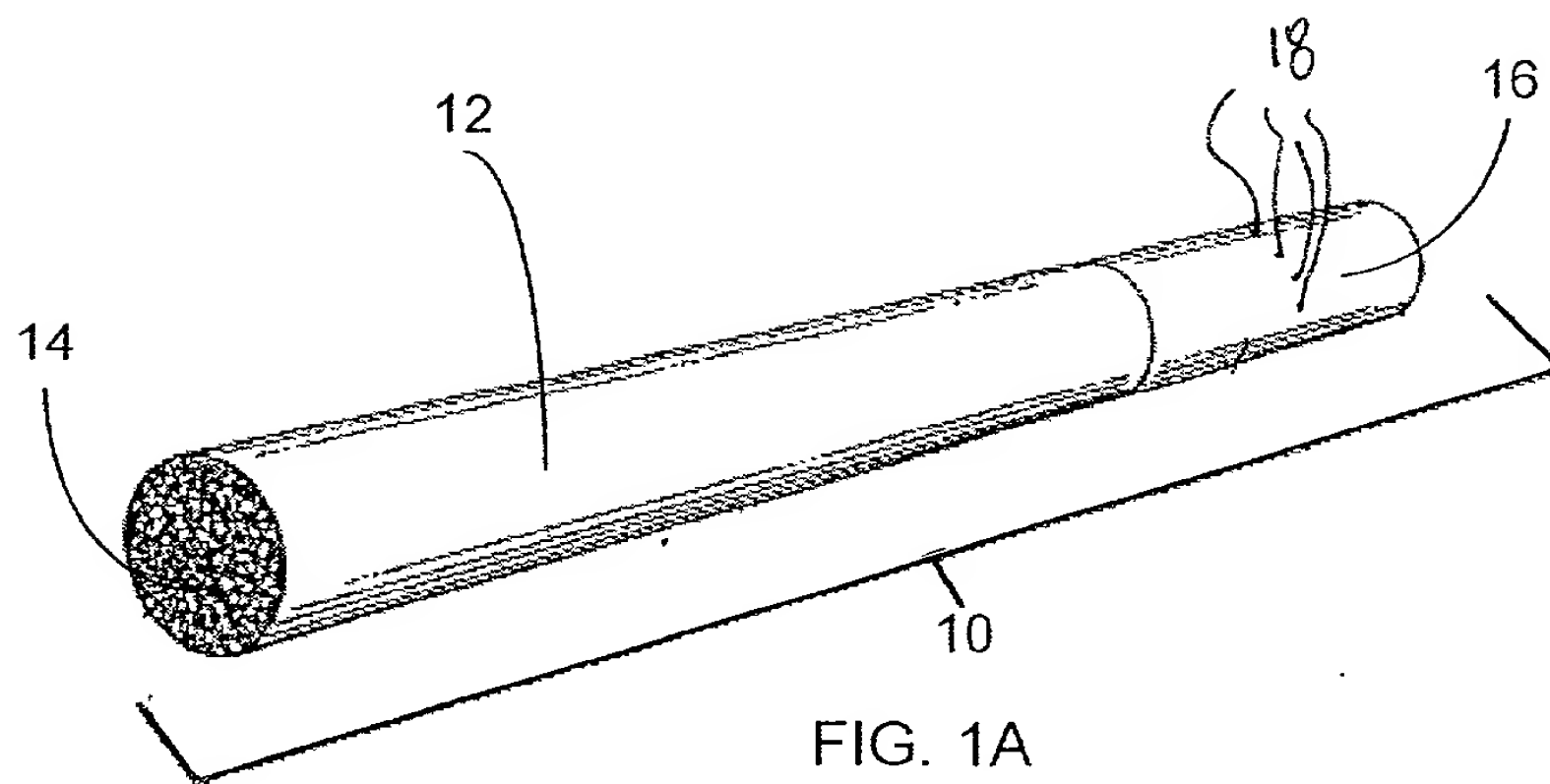
[illegible]

FIG. 1A

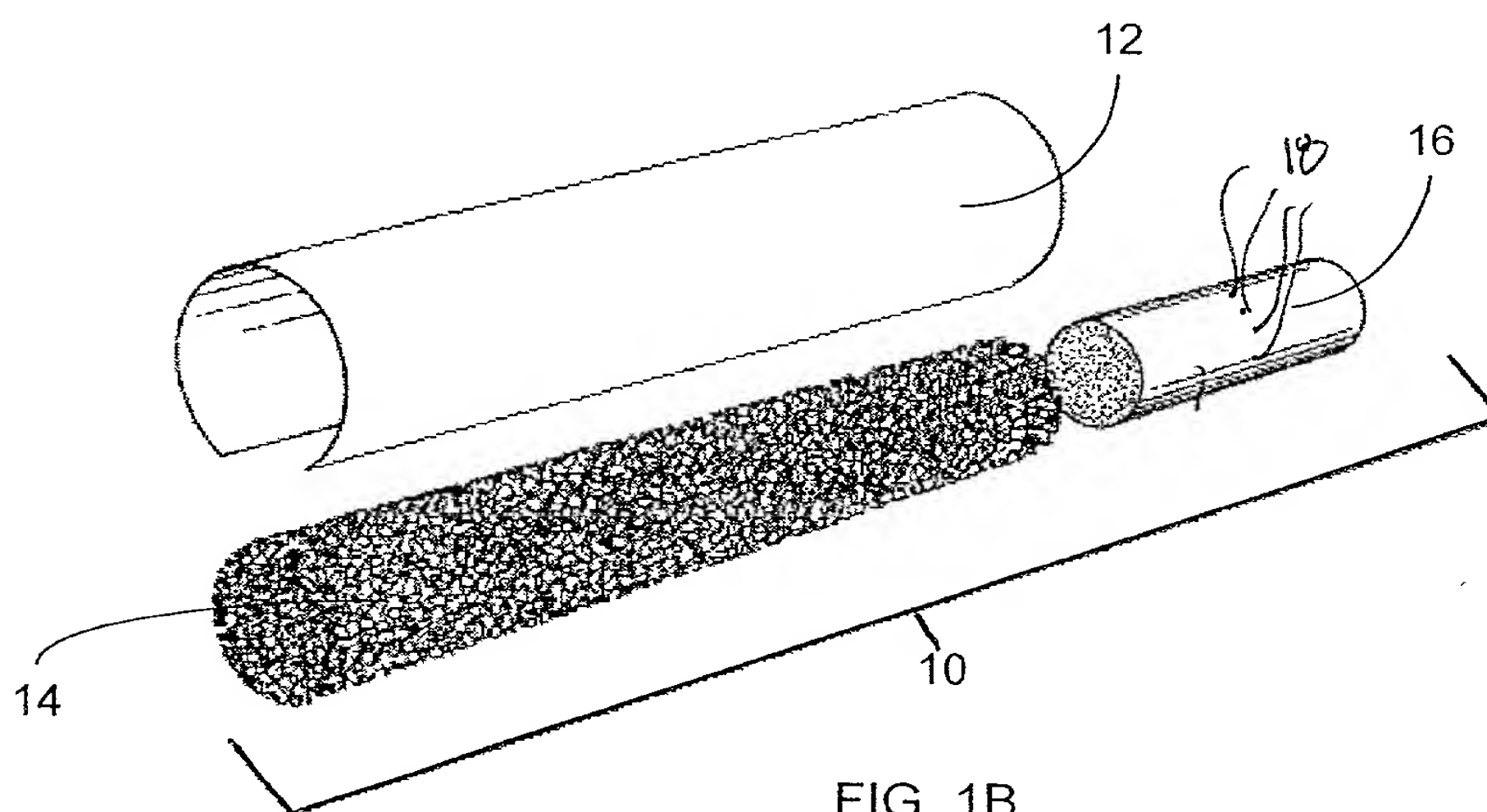


FIG. 1B

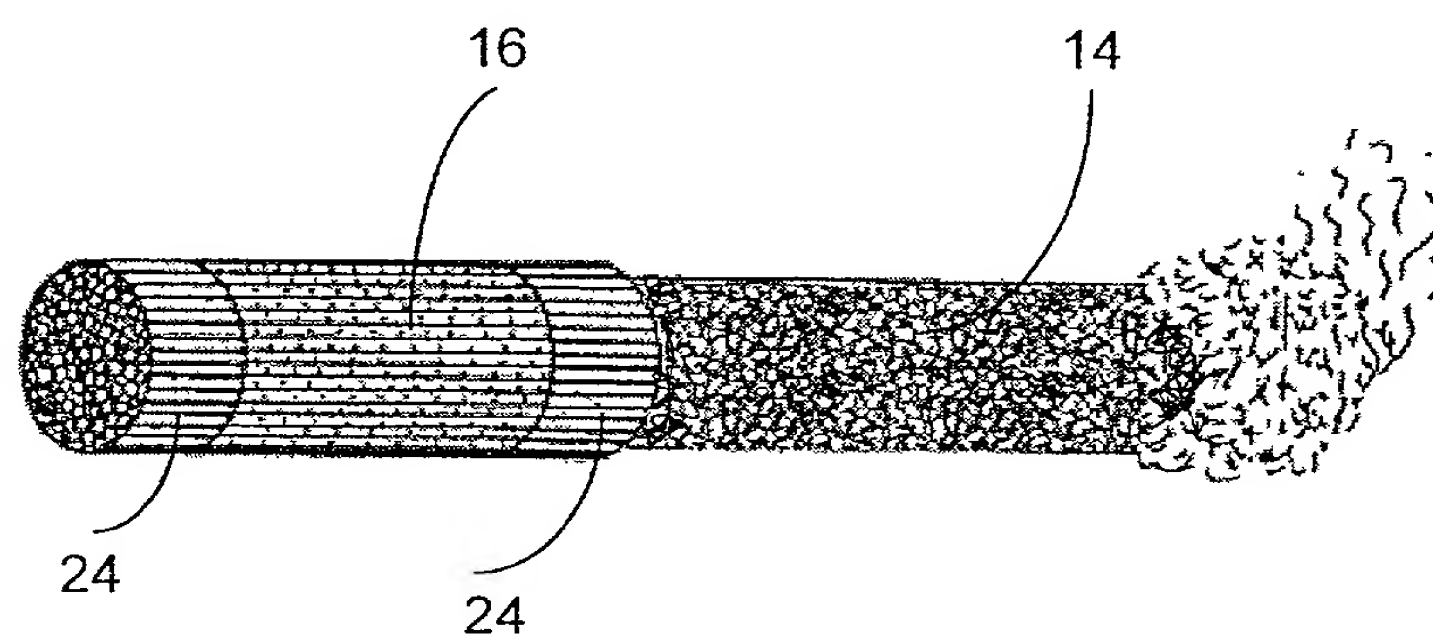


FIG. 2



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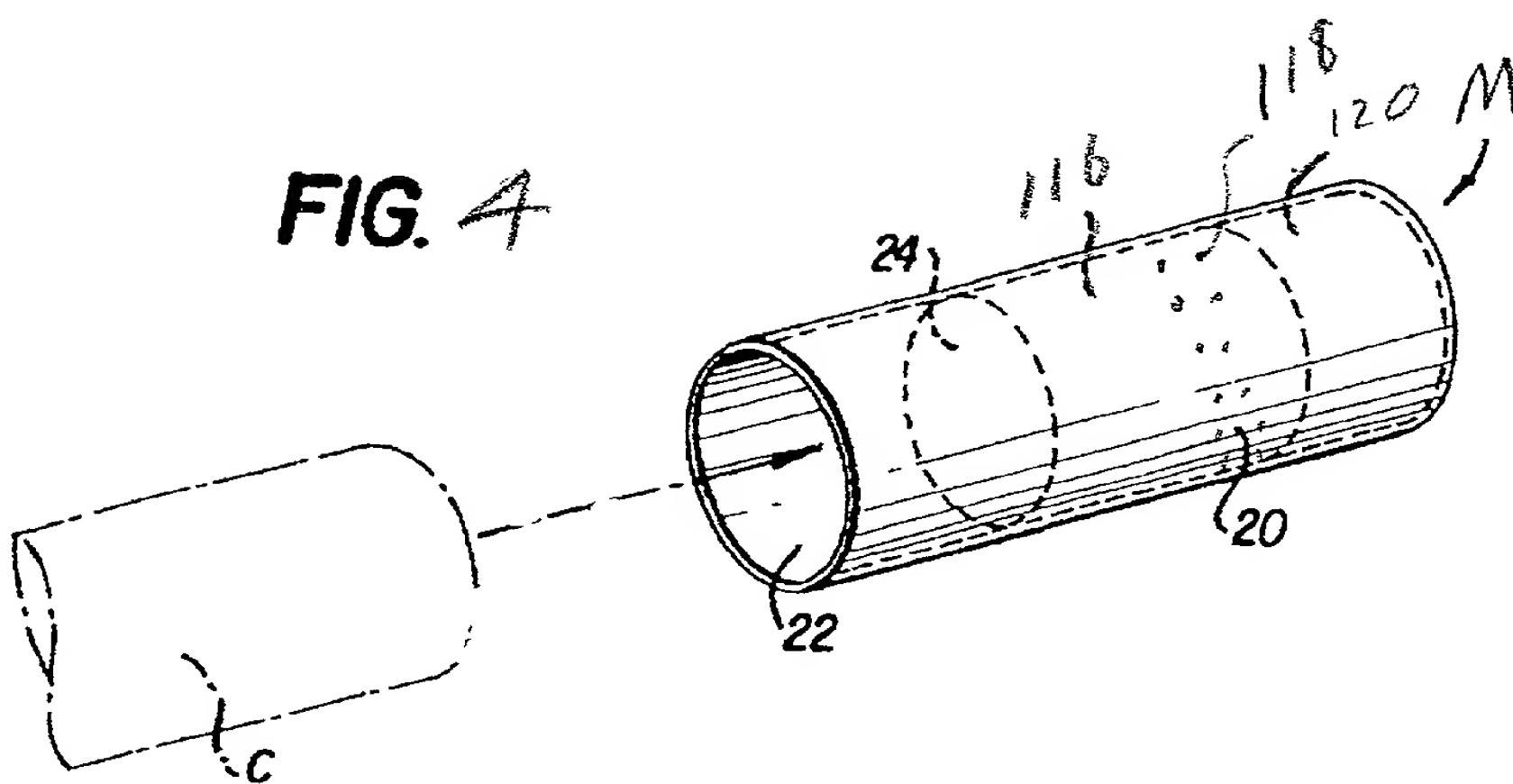
graph TD
    A((A)) --> B[Draw on Smoking Article]
    B --> C[CO Diverted from Main Stream Smoke]
    C --> D{Catalyst?}
    D -- Yes --> E[CO Oxidized to CO2]
    D -- No --> F[CO Concentration Increased]
    E --> G{Venting Holes?}
    G -- Yes --> H[CO2 Diverted Through Venting Holes]
    G -- No --> I{Peripheral Pores?}
    I -- Yes --> J[CO2 Diverted Through Peripheral Pores]
    I -- No --> K[CO2 remains in Main Stream Smoke]
    F --> L{Venting Holes?}
    L -- Yes --> M[CO Diverted Through Venting Holes]
    L -- No --> N[CO Diverted Through Peripheral Pores]
    H --> Exit1[ ]
    J --> Exit2[ ]
    K --> Exit3[ ]
    M --> Exit4[ ]
    N --> Exit5[ ]
    Exit1 --> A2((A))
    Exit2 --> A2
    Exit3 --> A2
    Exit4 --> A2
    Exit5 --> A2

```

fig 3

[illegible]

**FIG. 4**



**RULE 63 (37 C.F.R. 1.63)**  
**DECLARATION FOR PATENT APPLICATION**  
**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

As a below named inventor, I hereby declare that my residence, post office address and citizenship are as stated below next to my name, and I believe I am the original, first and sole inventor (if only one name listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled A SMOKING ARTICLE INCLUDING A SELECTIVE CARBON MONOXIDE PUMP the specification of which (check applicable box(es)):

☒ is attached hereto.  
☐ was filed on \_\_\_\_\_ as U.S. Application Serial No. \_\_\_\_\_  
☐ was filed as PCT international application No. PCT/\_\_\_\_\_/\_\_\_\_\_ on \_\_\_\_\_ and (if applicable to U.S. or PCT application) was amended on \_\_\_\_\_

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above. I acknowledge the duty to disclose information which is material to the examination of this application in accordance with 37 C.F.R. 1.56(a). I hereby claim foreign priority benefits under 35 U.S.C. 119/365 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed or, if no priority is claimed, before the filing date of this application:

**Prior Foreign Application(s):**  
**Application Number**

**Country**

**Day/Month/Year Filed**

I hereby claim the benefit under 35 U.S.C. §119(e) of any United States provisional application listed below:

**Prior Provisional Application(s):**  
**Application Serial No.**

**Day/Month/Year Filed**

I hereby claim the benefit under 35 U.S.C. 120/365 of all prior United States and PCT international applications listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in such prior application in the manner provided by the first paragraph of 35 U.S.C. 112, I acknowledge the duty to disclose material information as defined in 37 C.F.R. 1.56(a) which occurred between the filing date of the prior applications and the national or PCT international filing date of this application:

**Prior U.S./PCT Application(s):**  
**Application Serial No.**

**Date/Month/Year Filed**

**Status: patented,  
pending, abandoned**

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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3) Inventor's Signature

Inventor's Name (typed)		Date	
	First Middle Initial Family Name		Citizenship
Residence (City)		State/Foreign Country)	
Post Office Address		Zip Code	

**FOR ADDITIONAL INVENTORS, check box ☐ and attach sheet with same information and signature and date for each.**

**Rhodes & Mason (4/98)**